DEMONSTRATION OF A LARGE SCALE B.T. APPLICATION AGAINST SPRUCE BUDWORM IN MAINE, 1980

A Cooperative Project Between The Maine Bureau of Forestry and The USDA Forest Service

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INTRODUCTION

The use of microbial control agents such as Bacillus thuringiensis (B.t.) has been explored for several decades. The high cost of microbials and the environmental acceptability of chemical insecticides precluded large scale use of microbials. In recent years, the chemical insecticides are becoming less acceptable to the general public and the cost of their application is increasing.

Various formulations of B.t. have been tested in Maine. As a result, about 21,000 acres were treated with Thuricide 16B in 1978. Almost twice that many acres were sprayed in 1979 using Thuricide 16B and Dipel 4L. The reasonably good success has led to the present plan to apply B.t. on 200,000 acres. Since it has never been used on such a large scale in the U.S., the economic feasibility, operational difficulties and the effectiveness of foliage protection need to be determined.

Administrative Considerations

The Record of Decision for the Final Environmental Impact Statement - 1980 Cooperative Spruce Budworm Suppression Project, Maine, advises that the USDA Forest Service is willing to participate in research, pilot tests, and demonstration projects with biological insecticides such as B.t. The State of Maine also is interested in the full utilization of such biological insecticides. This project is proposed to demonstrate that large scale application is mechanically possible and biologically effective.

Cooperation

This project is conducted with State of Maine's consent and cooperation. It will be administered by the State with technical assistance from the USDA Forest Service. Private landowner participation will conform to State laws and policies. Contributions by the cooperators will include financial cost sharing and personnel to carry out the purposes of the project.

Objectives

The primary objective of this project is to demonstrate that B.t. may be applied on a large scale (200,000 acres) to provide foliage protection from spruce budworm defoliation and to determine carry-over protection into the following year. The results will show the feasibility of mixing and loading of large volumes of B.t. formulations, the effectiveness of spray delivery with large helicopters, the cost of application and the effectiveness of foliage protection on balsam fir in 1980 and 1981.

AERIAL APPLICATION METHODS

Spray Area

The spray areas selected for B.t. application include the southwest area and the eastern area of the Spruce-Fir Protection District in Maine. Chemical insecticides will not be used in these areas because of State policy to limit chemical application to those areas where access can be monitored.

The general area selected for B.t. application may be divided into 4 geographical units - Princeton, Greenville, Houlton and Presque Isle. The units contain varying numbers and sizes of spray blocks.

In general, the terrain is flat, with many small streams criss-crossing the spray blocks. Human population occur in the vicinity of many blocks. All operational restrictions discussed in the final EIS and outlined in the EPA Standards (Appendix of EIS) will be adhered to.

Spruce Budworm Populations

Egg-mass surveys and stand condition evaluations from 1979 indicate that non-chemical areas have 2 major types of conditions. The areas with moderate budworm populations and reasonably good tree condition were chosen as top priority for B.t. application. Success with B.t. may not be great in areas where budworm populations are very high and where the tree damage is severe. The recommended guidelines from research suggest use of B.t. in areas with 35 or less larvae per 18-inch branch. Final assignments of B.t. formulation and rate for the specific spray blocks have not been made as of this date.

Prespray estimates: Larval population estimates will be made in all the blocks selected for intensive evaluation and for sample areas nearby used as checks.

Development Surveys: Maine Bureau of Forestry Entomology staff will follow spruce budworm development and advise the demonstration project staff when spray application should begin.

Timing of Application

The spray blocks will be released for B.t. treatment by the Maine Bureau of Forestry at 90% budbreak and when at least 75% of the larvae are in 3rd instar and 25% are in the 4th instar. On the basis of historical records, B.t. applications will begin on or about May 19.

Research data indicate that B.t. treatments provide effective foliage protection until the budworms reach 6th instar. Application will be suspended when 5 percent of the budworm population in a block is in the 6th instar.

Application Requirements

B.t. applications will be restricted to the normal environmental and meteorological conditions prescribed in the Final EIS, Appendix L (known as the EPA Standards). Also of particular concern will be moisture conditions on foliage during and immediately after application. B.t. will be applied when tree foliage is drip-dry and no rain is forecast within the next 2 hours for morning application and 6 hours for evening application.

Helicopters and Spray Systems

Bell 205 and 212 helicopters will be used primarily in pairs at each heliport. A total of 6 helicopters will be used. The maximum load will be 400 gallons each. The helicopter specifications will be described in the contract agreement.

The spraying system will consist of an electrical pump driving the insecticide from the hoppers through spray booms and nozzles. The spraying system will be calibrated for 45 psi pressure, 80-90 mph air-speed and 50 ft. height of spray release. All the helicopters will be calibrated before release to the heliports to determine the acceptability of droplet spectra and swath width. The droplet spectra should be about 200 microns mmd and 100-150 ft. swath width.

Heliports

Tentative plans show at least 8 heliports to be located for B.t. spraying. More may be added as final spray blocks are confirmed. Heliports will be located within 5 miles of most spray blocks. The operational design, housing and arrangements are outlined in the Operations Manual, Maine Bureau of Forestry.

Insecticides

Commercial grade B.t. will be purchased by the Maine Bureau of Forestry from Sandoz Corp. (Thuricide 16B) and Abbott Laboratories (Dipel 4L). These are EPA registered materials for use against the spruce budworm in the spruce-fir forest. The following formulations and volumes will be used.

Dipel 4L will be applied on 100,000 acres at the registered rate of 8 BIU's in 64 fl. oz. per acre. The tank mix will have for each acre, 32 fl. oz. of Dipel 4L, 32 fl. oz. of water. Chevron sticker will be added at 1:1600 parts of final mix.

Thuricide 16B will be applied on 100,000 acres at 8 BIU's per acre, but at two volume rates. One half of the area will receive 80 fl. oz. per acre, made up of 64 fl. oz. Thuricide 16B and 16 fl. oz. of water. The other one half of the area will receive 128 fl. oz. per acre rate, after more water is added. Both formulations will have Chevron sticker added at the same rate.

Mixing and Loading

The commercial preparations of B.t. are in 55 gallon drums. Mixing will be done at the heliports on the day of spraying. The final formulation of B.t. will be pumped into the helicopters through closed system piping. Maine Bureau of Forestry will monitor mixing and loading to insure that it is done properly.

Meteorology

Professional weather forecasting will be available from the Operational Project Headquarters. At the heliports, records will be maintained by Maine Bureau of Forestry on wind conditions, rainfall and temperature at the time of spraying. Spraying will be limited to early morning and late evening periods when winds are at least 2 mph, but not exceeding 10 mph at the tree-top level.

EVALUATION METHODS

Project evaluation will be separated into two phases - application and efficacy. Mixing, loading and delivery of the biological insecticides will be part of the application evaluation. Defoliation prevention estimates for 1980 and 1981 will constitute the efficacy evaluation.

Application

Most of the application evaluation will be based on records maintained at the heliports and by the aerial monitors.

Heliport Records: Heliport records will be maintained by the Maine Bureau of Forestry. These records will be maintained in such a way that the final mixture and volume of insecticide delivered to each spray block can be identified. Mixing records will show the type and gallons of B.t. used in each batch; type of ingredients and volumes added; and gallons and batch numbers delivered to each spray block. Samples will be taken from the final tank mixes going to the selected evaluation blocks and analyzed for biological activity. USDA Forest Service will collect and process samples for those blocks being evaluated.

Any unusual activities and problems will be documented to provide opportunites for future improvements.

Aerial Monitoring: Maine Bureau of Forestry will monitor from aircraft all the B.t. spray applications to observe and correct deficiencies. Unusual activities and problems will be documented, particularly as these may effect foliage protection efficacy.

Spray Deposit Assessment: USDA Forest Service will carry out spray deposit assessment. The spray deposit assessment will be made at each sample tree in the spray blocks selected for evaluation. Two sample points will be established in openings in the vicinity of each sample tree (Thus, 6 samples per cluster in 160 clusters will be evaluated).

The B.t. spray will be collected on millipore filters (47mm diameter gridded millipore filters) set out before spraying. Wherever possible, the filters will be set out just before spraying and picked up within an hour afterward. However, the filters may be set out the evening before and picked up before noon the following day. Heavy winds, dew and rain may damage the filters, and a replacement is required.

The collected filters will be placed in individual envelopes and stored in a cool dry place until incubation. Storage should not exceed a month. To determine the spore colony count, the filters will be placed on tripticase soy agar in petri dishes (exposed side up). The plates will be incubated at 29°C (+ 1) for 18-24 hours. At that time the number of colonies per cm^2 will be determined.

Costs: The cost of large scale B.t. application are not known and generally, are assumed to be high. Some estimates reported to the public indicate $25 per acre. Maine Bureau of Forestry estimates indicate that costs should be less than one half of that. All the contracted and purchase expenditures for the B.t. application will be calculated to give a reasonable estimate for future reference.

The Princeton area where many small blocks will be sprayed present a unique method of application. Here, the most vulnerable stands have been selected out for treatment, rather than spraying large areas. The expected costs will be higher. The cost per acre of host type protected will be determined in this area and compared to estimated costs if large block design had been used. Evaluation of this targeted treatment deserves special attention since future project planning may follow this trend.

Meteorological Records: Temperature, relative humidity, wind strength and direction will be recorded by the Maine Bureau of Forestry for each sample block at the time of spraying. Weather data within 10 miles from the block will be acceptable. In addition, rainfall and temperature records will be kept for the geographical unit for 1-2 weeks after spraying.

BIOLOGICAL EVALUATION

Assumptions and Variables

The major assumptions in the design are that all areas and blocks have similar balsam fir conditions and spruce budworm populations. If any differences occur these will be evaluated within a region through replication. The presently known variables are the 2 formulations of B.t., likely biological differences because of regional spatial distribution, and block sizes, which may influence carry-over effects.

Dipel B.t. formulation will be applied at 64 fl. oz. per acre, while Thuricide 16B will be applied at 80 fl. oz. and 128 fl. oz. per acre. The biological toxicity of both formulations should be similar (8 BIU's per acre). The formulations require different mixing rates, and will require different calibration of aircraft. Therefore, under operational constraints to get the whole job done within a limited time period when the insect is susceptible, time will not allow pairing of these variables, but will require each of the materials to be applied at separate heliports.

Spray block size may not affect significantly the operational success of the current year's control. However, smaller blocks may be more readily re-invaded by egg-laying moths to mask carry-over effects of the B.t. treatments. Therefore, evaluation will be intensified in the Princeton area where most of the treatment blocks are small.

Early application will be timed for the 3rd and 4th instar larvae and presence of new needles as targets for spray deposition. However, because of the large scope of the project, very likely the later blocks will have populations that have gone through 5th instar, and also have done some feeding on the current foliage.

Sampling Design

Mean defoliation will be determined for each sample cluster. The average defoliation between 40 sprayed clusters and 40 unsprayed clusters will be compared using a grouped t test. The adequacy of protection will be evaluated by the comparison of proportion of clusters with adequate new growth (35% or better).

Table 1. -- Sampling design

Geographical spray units	Treatment						Trees per treatment		Branches per collection			
	Sprayed			Unsprayed					Prespray		Postspray	
	Blocks No.	Clstrs/Blocks No.	Total Clstrs No.	Blocks No.	Clstrs/Blocks No.	Total Clstrs No.	Per Cluster No.	Total No.	Per Tree No.	Total No.	Per Tree No.	Total No.
Princeton	8	5	40	8	5	40	3	120	1	120	2	240
Greenville	4	10	40	4	10	40	3	120	1	120	2	240
Houlton	4	10	40	4	10	40	3	120	1	120	2	240
Caribou	4	10	40	4	10	40	3	120	1	120	2	240

Geographical Units

Each unit will represent a region or a unique operational condition which might influence variables being measured. At present 6 units are being considered: Caribou, Beddington, Greenville, Haynesville, Monticello and Princeton. Additional units may be established at a later date when the operational plans are more fully developed. Within each unit 5 or more spray blocks will be available for evaluation.

Evaluation Blocks

In each unit a number of treatment blocks will be selected for statistical evaluation. The Princeton unit, which is composed of many small spray blocks of 50-500 acres, will have 8 spray blocks evaluated. The remaining units have spray blocks with 500 acres to several thousand acres each. In these units 4 blocks per unit will be chosen. These blocks will be chosen on the basis of access and to represent spatial distribution within the unit.

A check block, or untreated area will be paired with each sprayed block chosen. These unsprayed blocks will have similar stand conditions to the sprayed blocks.

Sample Clusters

In each large treatment and check block, 10 sample clusters will be marked. These clusters will be dispersed in such a way that only one cluster can be sprayed in a single swath line. Thus, 10 swath lines will be evaluated.

In the small treatment blocks at Princeton three sample clusters per block will be established. Again, the check blocks will be selected in the areas nearby.

Trees

Each cluster is a group of 3 dominant/codominant balsam fir trees as close together as possible. These trees will be marked for sampling in the current year, and the following spring.

Sampling

Two collections of branch samples will be made in 1980 and one collection in 1981. Field collections will be made by USDA Forest Service and Maine Bureau of Forestry.

The first collection will be not more than 3 days before, or 1 day after spraying. One branch, 18 inches long, will be taken from the midcrown of each sample tree, bagged, labelled, and delivered to a laboratory.

The second collection will be taken after all larval feeding has ceased. At this time 2 branches per tree will be collected, similar to the prespray samples, and the degree of defoliation estimated. Spruce budworm pupal population estimates will be made at this time.

Spruce budworm mortality estimates are not likely to provide adequate information on the adequacy of protection. The literature suggests that budworm larvae may survive for a relatively long period after treatment, and even possibly pupate. However, these same larvae stop feeding shortly after ingesting B.t. We expect great variability in population age because of the prolonged treatment period. The later treated blocks may have older larvae which may not die before pupation, but may be prevented from feeding. Normally the 6th instar larvae cause the greatest amount of foliage loss.

Laboratory Examination

Sample branches from the first collection will be delivered to the regional spruce budworm laboratories, Maine Bureau of Forestry. The samples will be kept in a cool place until examination. Samples collected from the sprayed blocks after spraying must be examined within 3 days, since mortality is likely to occur after that time.

The laboratory examination to be conducted by Maine Bureau of Forestry laboratory personnel will include the number of larvae per branch, determination of median stage of development and assessment of defoliation as prescribed in the B.t. core test. Field instructions will be provided in an addendum.

Defoliation Estimates

Defoliation estimates will be made at the time of spraying and later after larval feeding and shoot growth is completed. Defoliation estimates will be made in a manner similar to the recommended CANUSA B.t. Core Test Defoliation Evaluation. Defoliation estimates in the core test recommend 25 shoots on each of 4 branches per tree on 15 sample trees, for a total of 150 estimates per block. In our project, we will examine 10 shoots on each of 2 branches for 120 trees, or 240 estimates per block. Individual shoot defoliation estimates will use Core Test criteria - nil, 1-25%, 26-50%, 51-75%, 76-100% (but shoot axil intact) and completely destroyed shoot, or bud.

Larval Population Estimates

Larval population counts will be made in the laboratory to estimate population density at the time of spraying. The final estimates will give the number of budworm larvae per branch. In addition, 100 larvae will be preserved from each sample block to estimate average stage of development. The percentages in each instar will be determined.

Egg-Mass Population Estimates

The number of egg-masses per 18" branch will be determined after moth activity has stopped in the spray block and any surrounding areas from which immigration of moths might occur. The egg-mass data will be part of the information used to evaluate carry-over effects. If high budworm populations are expected in 1981, and the area is rated for treatment, no further carry-over data will be collected.

Carry-over effects

Reports from some areas indicate that carry-over effects may occur from insecticide treatments. Insecticide kill may be so successful that it may require several years before population build-up occurs. Biological insecticides may permit completion of development of diseased larvae, but reduced vigor may appear during pupation, moth emergence and egg-production. Lowered vigor may also be encountered in the following generation.

B.t. itself apparently does not survive very long. About 29 reports indicate that the B.t. is ineffective within 3 months after treatment. None of the studies reported B.t. survival in soil or foliage 1 year after treatment.

Our evaluation on carry-over effects will be limited to defoliation measurements in the following year (1981). Comparisons will be made between large blocks and small blocks, because of expected differences from immigration from the surrounding areas.

Special Project Evaluations

The Project Entomologist, Maine Bureau of Forestry, will continue special evaluations to determine B.t. effectiveness in unique situations that may occur in future operations. Among these may be high larval population densities and consecutive year B.t. treatments. These efforts will be coordinated with the subject evaluation to avoid duplication.

PROJECT ADMINISTRATION

Organization and Responsibilities

This project is a joint endeavor between USDA Forest Service and Maine Bureau of Forestry. The administrative requirements of both organizations must be satisfied.

Maine Bureau of Forestry will be primarily responsible for the purchase of insecticides, contract for mixing, loading and delivery of proper formulation and rates, and supervision of aerial application.

USDA Forest Service will be primarily responsible for the evaluation of treatment effectiveness.

The organizational chart shows the supervisory lines of responsibility, and areas of direct cooperation between the two agencies.

The operational phase at each of the heliports will be directed by the Heliport Supervisors and one assistant. Mixing and loading will be handled by contractors staff. Additional personnel will be assigned as needed. Among the Heliport Supervisors responsibilities will be the supervision of contract helicopter crews and state monitors.

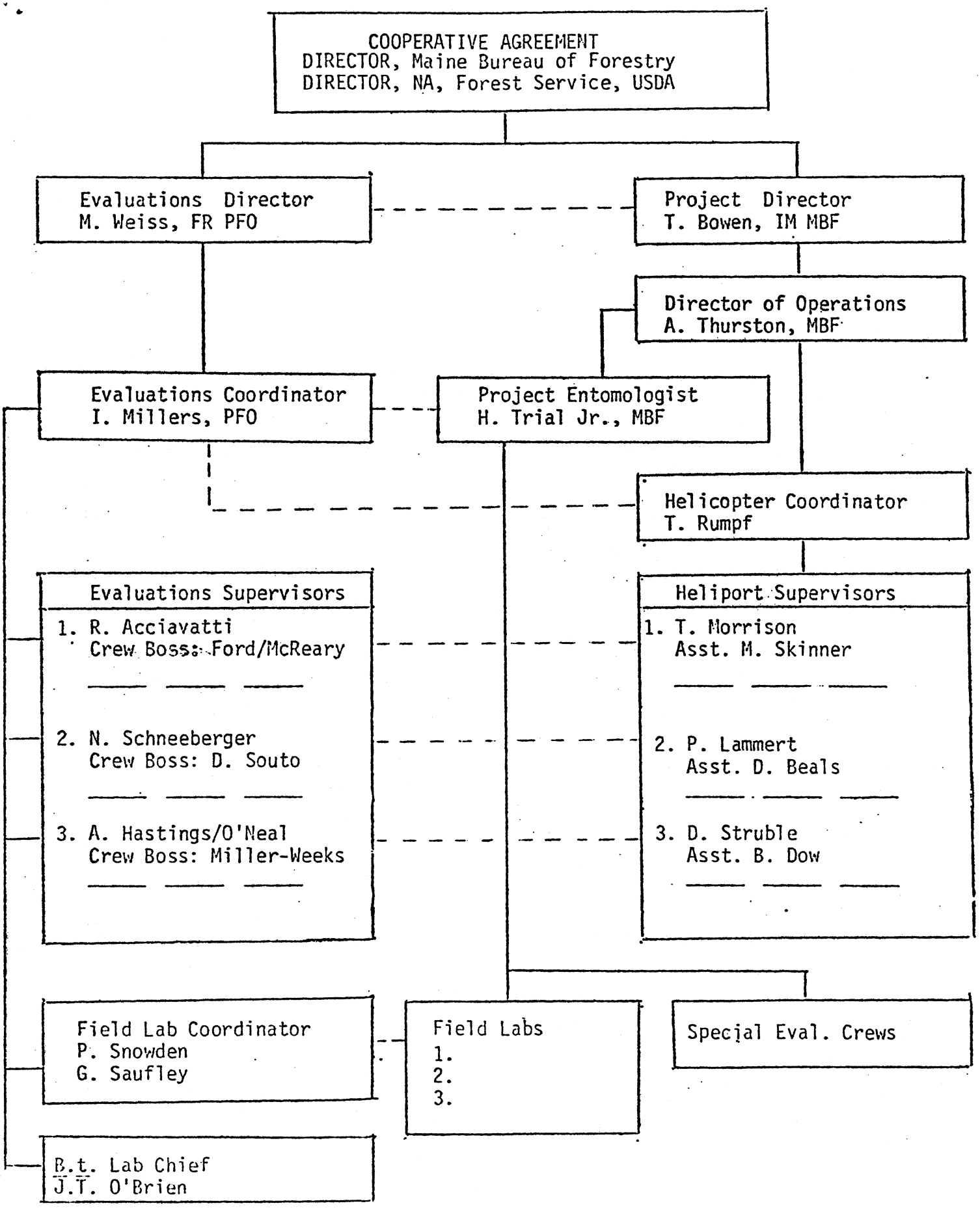
The evaluation phase at each heliport will be supervised by a Unit Supervisor, who will be located at the heliport. Field sampling will be done by a crew of 4, one of which will be assigned as the Crew Boss.

Support Services

The support services for the operational phases such as personnel, contracting and purchases will be provided by the State of Maine. For evaluation phases where USDA Forest Service is involved, assistance will be provided by NA Support Services.

Transportation

Maine Bureau of Forestry will provide transportation for all their personnel. The USDA Forest Service is under severe travel restrictions. Present estimates indicate that 23,000 vehicle miles of travel will be required by USDA Forest Service before July 1, 1980, and about 10,000 miles after that, but before October. The NA will determine how these travel restriction may be resolved.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2.
3.
Special Eval. Crews
B.t. Lab Chief
J.T. O'Brien

SAFETY PLAN

Safety practices are outlined in the Spruce Budworm Operations Manual, Maine Bureau of Forestry. The items covered are shown in the following excerpted Table of Contents:

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REPORTS

Detailed reports will be prepared cooperatively between the Maine Bureau of Forestry and USDA Forest Service. These reports will be released as the particular phase of the projects are completed - application, field evaluation, carry-over effects. The final report will combine all the progress reports. The following schedule is planned:

1. Spray Project Report - It will be prepared under the direction of Maine Bureau of Forestry; due date is September 1, 1980.

2. Evaluation 1980 - The analysis and the report will be prepared under the direction of Portsmouth Field Office, USDA Forest Service; Due date is January 1, 1981.

3. Carry-over Effects - The analysis and report will be prepared under the direction of Portsmouth Field Office, USDA Forest Service; due date is January 1, 1982.

4. Final Report - This will be a joint report to be prepared under the direction of USDA Forest Service; due date is March 1, 1982.

ESTIMATED BUDGET

Maine Bureau of Forestry

The following expenditures are proposed by Maine Bureau of Forestry to be cost-shared with USDA Forest Service in equal proportions.

SALARY		$ 75,000
TRANSPORTATION		10,000
SERVICE CONTRACTS		
Mix + Load - Chempro	50,000	
Helicopters - Evergreen	930,562	
Aerial Monitoring	25,000	1,005,562
SUPPLIES		
Insecticide, B.t.	925,000	
Miscellaneous	17,100	942,100
TOTAL		$2,032,662
		($1,016,331 State)
		($1,016,331 Federal)

Northeastern Area, USDA Forest Service

The estimated budget includes expenses of Portsmouth Field Office, and detailed personnel from other field offices in NA. It is assumed that permanent personnel detailed to Maine will cover their own travel arrangements and while in Maine, utilize their mileage allotments. The total is the supplemental funding needed by NA field offices to carry out the proposed plan.

SALARIES	TOTAL	PFO	DFO	SPFO
Temporary	$10,000	$ 5,000	$ 5,000	$ -
Full Time	contributed	contributed	contributed	contributed
Over Time	15,000	10,000	2,500	2,500
PER DIEM				
Temporary Per Diem	4,000	contributed	4,000	-
Full Time Per Diem	5,500	contributed	4,000	1,500
TRANSPORTATION				
Temporary Transportation to Maine	1,500	-	1,500	-
Full Time Transportation to Maine	2,500	-	1,500	1,000
Vehicles (23,000 mi. in 3rd 1/4) (10,000 mi. in 4th 1/4)	8,000	8,000	-	-
OBSERVATION AIRCRAFT	5,000	5,000	-	-
MISC. SUPPLIES	5,000	5,000	-	-
TOTAL	$56,500	$33,000	$18,500	$5,000